

## Ground Lesson: Flight Instruments

### Objectives:

1. to understand the flight instruments, and the systems that drive them
2. to understand the pitot static system, and possible erroneous behavior
3. to understand the gyroscopic instruments
4. to understand the magnetic instrument, and the short comings of the instrument

### Justification:

1. understanding of flight instruments is critical to evaluating proper response in case of failure
2. knowledge of flight instruments is required for the private pilot checkride.

### Schedule:

Activity	Est. Time
Ground	1.0
<b>Total</b>	1.0

### Elements Ground:

- overview
- pitot-static instruments
- gyroscopic instruments
- magnetic instrument

### Completion Standards:

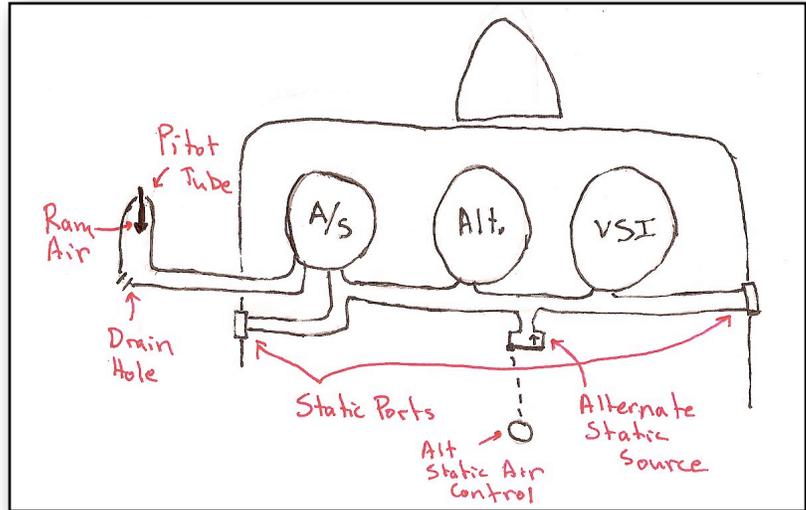
1. when the student exhibits knowledge relating to flight instruments including their failure symptoms

## Presentation Ground:

### pitot-static system

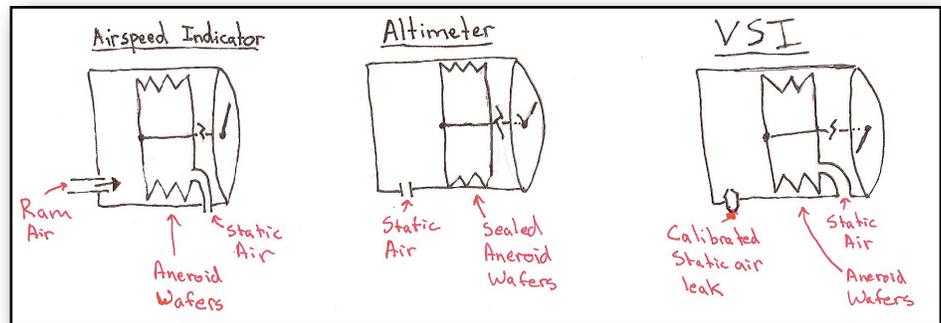
#### 1. overview

- (1) pitot-static system uses ram-air and static air measurements to produce readings.
- (2) pressure and temperature effect the altimeter
  - i. remember - "Higher temp or pressure = Higher altitude"
  - ii. altimeters are usually adjustable for non-standard temperatures via a window in the instrument
    - (i) 1" of pressure difference is equal to approximately 1000' of altitude difference



#### 2. components

- (1) static ports
- (2) pitot tube
- (3) pitot heat
- (4) alternate static ports
- (5) instruments - altimeter, airspeed, VSI



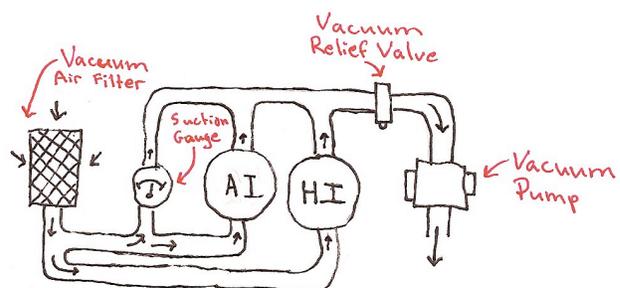
### gyroscopic system

#### 1. overview

- (1) vacuum :system to allow high-speed air to spin certain gyroscopic instruments
- (2) typically vacuum engine-driven for some instruments, AND electrically driven for other instruments, to allow back-up in case of system failure
- (3) gyroscopic principles:
  - i. rigidity in space - gyroscopes remains in a fixed position in the plane in which it is spinning
  - ii. precession - when a force is applied to a gyroscope, the reaction is 90° ahead of the applied force, in the same direction

#### 2. vacuum components

- (1) pump
- (2) relief valve
- (3) suction gauge
- (4) low vacuum warning switch
- (5) air filter
- (6) instruments



## magnetic compass

### 1. magnetic field

- (1) inside earth is basically one gigantic magnet, with magnetic fields flowing from one pole to the other
  - i. the field is parallel to earth at the equators, and vertical at the poles. It varies constantly between
- (2) magnetic north is different than true north, and thus you have varying magnetic variation depending on where you are in relation to the two north's.

### 2. overview

- (1) the magnetic compass takes advantage of magnetic fields, and has a sensing magnet that aligns itself with the fields
- (2) the instrument is essentially a sensing magnet, attached to a compass card, floating in a liquid that allows it to rotate freely
- (3) because of the design of the instrument, and it's reliance on earth's magnetic field, there are quite a few errors associated with the instrument, and really should only be used during straight-and-level flight, and during emergencies as a backup.

### 3. compass errors

- (1) variation - differences between magnetic north and true north. Varies based on geographic location
- (2) compass deviation - errors caused by aircraft installation configuration. metals and instruments cause the sensing magnet to deviate from precise magnetic field alignment
  - i. each airplane has a deviation card which defines proper headings to use, given desired headings
  - ii. of note, headsets or any metal objects near the magnetic compass will cause more significant deviations
- (3) magnetic dip
  - i. due to the magnetic fields vertical component (except at the equator), the sensing magnet wants to "dip" to align properly.
  - ii. to counteract magnetic dip a compass weight is used
  - iii. This is the cause of the next two operational errors
- (4) acceleration/deceleration errors - fluctuations in readings during speed changes
  - i. most pronounced on east/west headings, and acceleration causes an indicated turn towards north, and deceleration causes an indicated turn towards south
  - ii. due to inertia of the compass weight, it lags slightly during acceleration, and leads slightly during deceleration
  - iii. remember ANDS - **A**ccelerate **N**orth, **D**ecelerate **S**outh
  - iv. this applies to the Northern Hemisphere, in the Southern it is different
- (5) turning errors - fluctuations in readings during turns
  - i. due to magnetic dip, turns *from* a heading of north or south will cause the compass to have turning errors
  - ii. the magnitude of error is approximately equal to the latitude
  - iii. remember - "to the North Leads, to the South Lags" or
  - iv. UNOS - **U**ndershoot **N**orth, **O**vershoot **S**outh